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Catch and Effort Statistics for the Sockeye Salmon Sport Fishery During the Late Run to the Russian River With Estimates of Escapement, 1992

by

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ABSTRACT

A direct expansion creel survey of the late-run Russian River recreational fishery was conducted in 1992 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. Anglers expended 87,918 angler-hours to harvest 26,101 sockeye salmon from the late run (20 July-18 August). The harvest rate for the late run was 0.297 sockeye salmon per hour of angler effort. Approximately 84% of the total fish harvested during the late run were taken from the confluence area of the fishery.

A total of 63,478 sockeye salmon bound for spawning areas were counted through the weir at the outlet of Lower Russian Lake during the late run. This total exceeds the escapement goal of 30,000 that has been established for the late run.

Predominant age groups of the harvest and the escapement for the late run were 2.2, 2.1, and 2.3. The majority of the fish harvested (74.7%) and the escapement (81.4%) were age 2.2. The age composition of the confluence area harvest, the river area harvest, and from the weir differed from each other during some or all of the temporal components sampled during the late run. Estimates of the age composition of the total late return (apportioned harvest plus escapement) indicated that the late run was comprised primarily of age-2.2 and age-2.3 sockeye salmon (79.8% and 10.2%, respectively).

A stream survey indicated that a minimum of 4,980 sockeye salmon spawned in the Russian River downstream from the Russian River falls. Carcass sampling indicated that the most abundant age group (1.3) comprised 68.4% of the population that spawned downstream from the falls.

KEY WORDS: Russian River, sockeye salmon, *Oncorhynchus nerka*, creel survey, direct expansion, harvest, effort, weir, escapement, age composition, recreational fishery, mean length at age, harvest rate.

INTRODUCTION

The Russian River is a clearwater stream located in the central Kenai Peninsula near Cooper Landing, Alaska. The drainage includes two large clearwater lakes, Upper and Lower Russian lakes, and terminates in the Kenai River approximately midway between Kenai and Skilak lakes (Figure 1). The second largest recreational fishery for sockeye salmon *Oncorhynchus nerka* in Alaska occurs in the Russian River and at its confluence with the Kenai River. Annual effort by anglers in this fishery has exceeded 450,000 angler-hours and annual harvests have exceeded 190,000 fish. Prior information on this fishery was presented by Lawler (1963, 1964), Engel (1965-1972), Nelson (1973-1985), Nelson et al. (1986), Athons and McBride (1987), Hammarstrom and Athons (1988, 1989), Carlon and Vincent-Lang (1990), Carlon et al. (1991), and Marsh (1992).

Sockeye salmon return to the Russian River in two temporal components, termed early run and late run. Historically, the total return of the late run has numbered nearly twice that of the total return of the early run. The late run typically arrives at the confluence of the Russian and Kenai rivers in mid to late July. Late-run fish typically move immediately into the Russian River and are present in the area open to fishing through August. Late-run fish are comprised of two segments based upon spawning location: (1) those spawning upstream of the Russian River falls, and (2) those spawning downstream from the falls. While most fish migrating through the falls spawn in Upper Russian Lake, others spawn in the tributaries to Upper Russian Lake and in the river section between the two lakes. These fish are primarily 2-ocean fish and rear in the two lakes.[1] The other segment spawns in the Russian River downstream from the falls. These fish, primarily 3-ocean fish, are more closely associated with the age structure of sockeye salmon spawning in the mainstem Kenai River (Cross et al. 1983, 1985, 1986). These fish are believed to spend their freshwater residency in Skilak Lake.

In addition to the sport harvest at the confluence of the Kenai and Russian rivers and in the Russian River, late-run sockeye salmon of Russian River origin are also harvested by a sport fishery in the mainstem Kenai River, a personal use dip net fishery near the mouth of the Kenai River, and a commercial fishery in upper Cook Inlet. Estimates of the total harvest of sockeye salmon by sport fisheries in the mainstem of the Kenai River have been reported annually since 1977 (Mills 1979-1992). The personal use dip net harvest has been estimated in the Statewide Harvest Survey since 1983 (Mills 1984-1992). The commercial catch and total return of sockeye salmon to the Kenai River have been reported by Cross et al. (1983, 1985, 1986).

The Division of Sport Fish of the Department of Fish and Game manages the recreational fishery to ensure that a minimum number of spawning sockeye salmon migrate through a weir at the outlet of Lower Russian Lake during the late run (Figure 2). The escapement goal of the late run, established in 1979 by the Alaska Board of Fisheries, is 30,000 fish. This goal is based upon evaluation of returns from past brood years. With the exception of 1977, when the escapement was 21,410 (Nelson 1978), the escapement goal has been achieved each year since 1975.

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[1] Juvenile sockeye salmon have been captured in nets in both lakes.

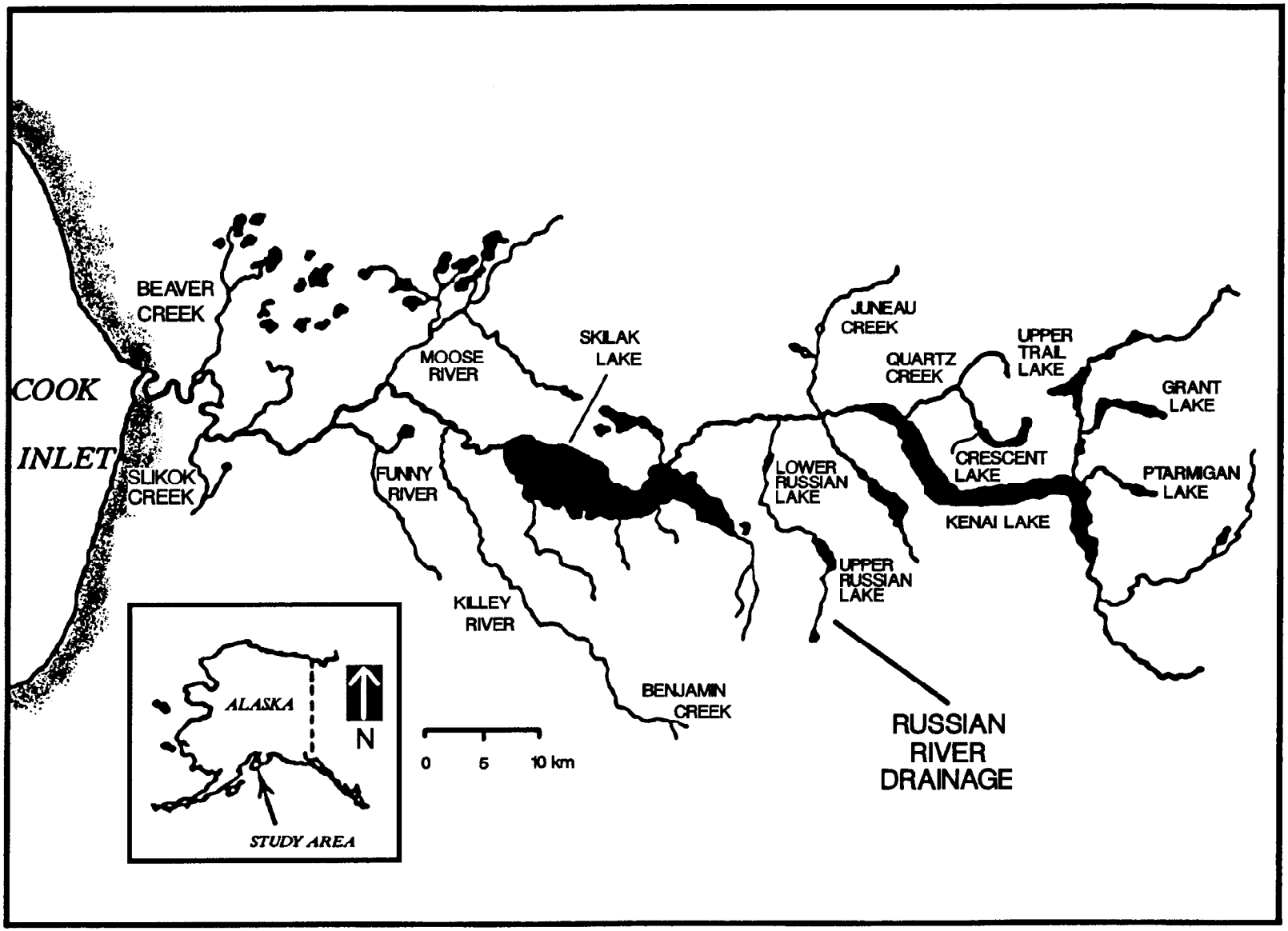

Figure 1. Map of the Kenai and Russian River drainages.

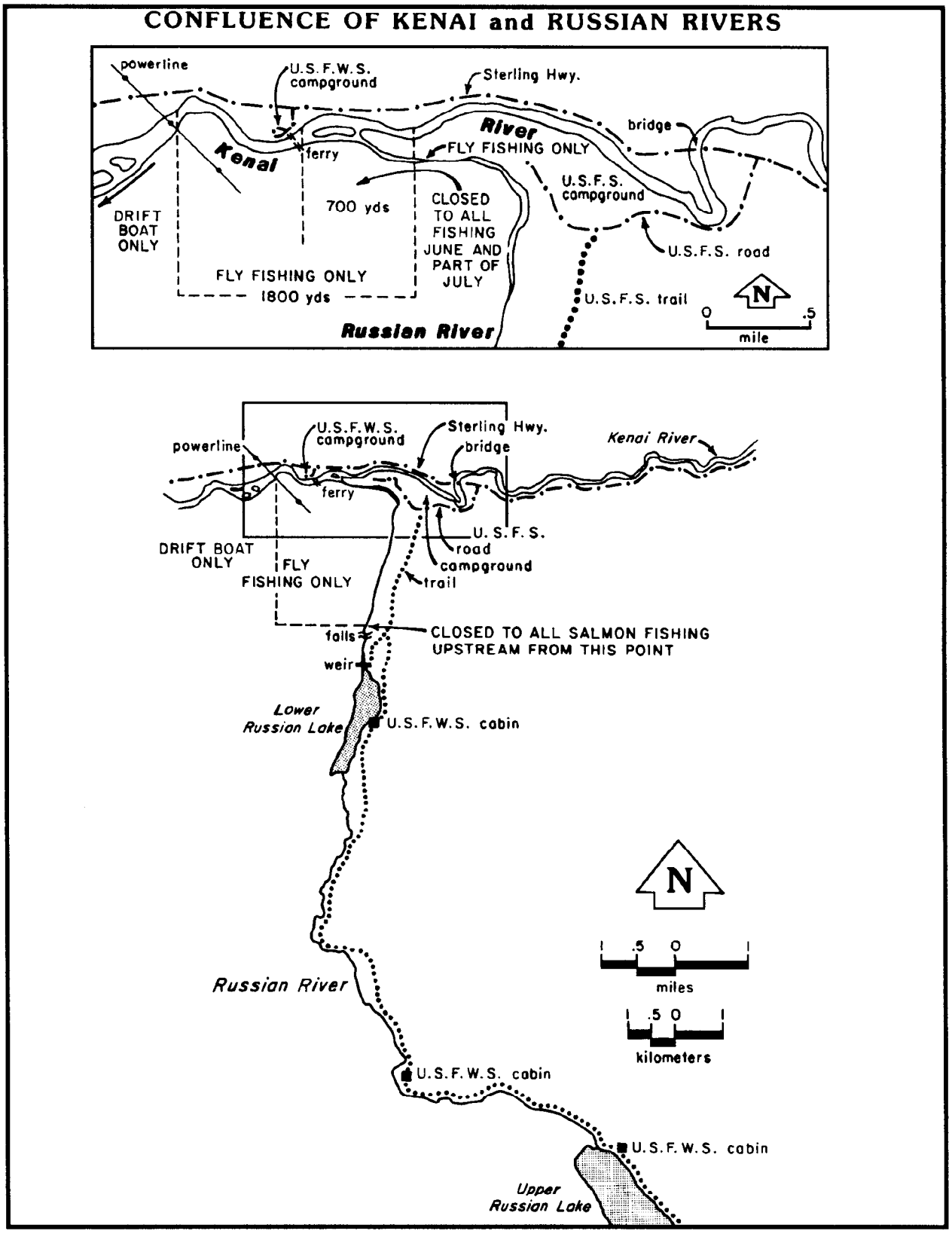

Figure 2. Detailed map of the Kenai and Russian River study area.

Because the recreational fishery for sockeye salmon at the Russian River is one of the largest in the state, there is a potential for overharvest. Precise and timely management decisions are required to ensure that an adequate escapement is obtained. The data necessary for these decisions are provided by a creel survey and a counting weir. The creel survey provides estimates of angler effort and harvest of the recreational sockeye salmon fishery. This recreational fishery occurs in the Kenai and Russian River "fly-fishing-only" area (Figure 2). Weir operations census the daily escapement. Estimates of the total inriver return (harvest plus escapement) and the age, sex, and size compositions of the return provide information to evaluate overall production and to estimate optimum spawning escapement levels.

From 1 June through 20 August 1992, the daily bag and possession limit for sockeye salmon taken from the Kenai/Russian River fly-fishing-only area was three fish of 406 mm (16 in) or more in length. Within this area, from a marker located 540 m (600 yd) downstream from the Russian River falls to a marker located on the Kenai River 1,620 m (1,800 yd) downstream from the confluence with the Russian River, only a single-hook unbaited, unweighted fly with a point-to-shank measurement of 9.5 mm (3/8 in) or less constituted legal terminal tackle. Any weights attached to the line were required to be a minimum of 457 mm (18 in) above the hook.

The objectives of the 1992 study were to:

1. estimate effort and harvest of late-run sockeye salmon for the recreational fishery;

2. estimate the escapement of the late run of sockeye salmon; and,

3. estimate the age, sex, and length distributions of the harvest and escapement of the late run of sockeye salmon.

METHODS

Study Area

The recreational fishery occurs in two areas: (1) the confluence area, which extends from the upper limit marker of the sanctuary area[2] downstream approximately 1.6 km to a marker on the Kenai River identifying the downstream limit of the "fly-fishing-only" area; and (2) the river area, which extends from the upper limit of the sanctuary area upstream approximately 3.2 km on the Russian River to a marker identifying the upper limit of the "fly-fishing-only" area.

Access to the two fishing areas is provided primarily by five access points. A United States Forest Service (USFS) campground located on the east side of the Russian River provides four access points in the form of four short trails which intersect the main riverside trail affording access to the river area.

[2] The sanctuary area begins in the Russian River 137 m upstream of the confluence with the Kenai River and extends downstream to a marker placed approximately 25 m (75 ft) immediately downriver of the ferry cable crossing (approximately 640 m).

The trails, which serve four camping/parking areas within the Russian River Campground, are designated with the following names: (1) Grayling, (2) Rainbow Trout, (3) Pink Salmon, and (4) Red Salmon. Access to the confluence area is primarily through a parking area administered by the United States Fish and Wildlife Service (USFWS) and located on the north bank of the Kenai River directly across from the Russian River confluence. Immediately adjacent to the USFWS parking area is a cable ferry which traverses the Kenai River, providing the fifth access point to the fishery. Most anglers fishing the confluence area use the ferry to reach the south bank of the Kenai River. Both the parking area and the ferry are operated privately under a concession administered by the USFWS. Some anglers also use the ferry to cross the Kenai River and then walk upstream to fish the Russian River area. Anglers may also use the USFS campground trails to gain access to the confluence area.

A stationary weir, constructed of metal and wood, is located just downstream from the outlet of Lower Russian Lake and approximately 360 m (400 yds) upstream from the Russian River falls. The weir has been described in detail (Nelson 1976) and provides a complete count of the late-run spawning escapement.

Study Design

Creel Survey:

A direct expansion creel survey was utilized during the 1992 late run. Based on results of previous creel surveys at the Russian River (Carlon and Vincent-Lang 1990), a stationary creel design was adopted in 1990, replacing the previous roving creel design (Neuhold and Lu 1957).

Sampling was stratified by access location to estimate harvest and effort, and was limited to three access locations. In 1990 and 1991, there were significant differences in use among the five access locations (Carlon et al. 1991, Marsh 1992). Creel data indicated that angler use was consistently dominated by three major sites: the ferry, Grayling, and Pink Salmon. These access sites represented more than 90% of the total harvest and effort and also contributed approximately 90% of the total variance for both the harvest and effort estimates. Therefore, only the ferry, Grayling, and Pink Salmon were sampled in 1992.

In an effort to reduce the overall variability of the estimates, a shift in the systematic sampling design of 1990 and 1991 was implemented in 1992. Estimates of effort, harvest, and their variances for the late run, based upon data collected in 1990 and 1991, were used to optimally allocate the available sampling days among the three major river access sites (Cochran 1977). During the late run, the ferry was sampled approximately every 2 days, Grayling every 3 days, and Pink Salmon every 4 days.

Area-specific (river or confluence area) harvest and effort were estimated by recording the area fished for each interviewed angler. In 1990 and 1991, approximately three-fourths of the harvest and effort occurred in the confluence area during the late run (Carlon et al. 1991, Marsh 1992). This is typical of the effort distribution in most years (Nelson et al. 1986). As a result of this concentration of harvest and effort, and because harvest rate (harvest per hour) is considered a management tool to index sockeye salmon

abundance at the confluence, the confluence access location (the ferry) was sampled every other day throughout the late run. This ensured that timely information regarding confluence harvest rates was available when formulating inseason management strategies.

The fishery was surveyed from 20 July to 18 August. The creel survey sampling day was 18 hours in length and was divided into six, 3-hour periods from 0600 to 2400 hours. A three-stage sampling design was used with days as primary units, periods as secondary units, and anglers as tertiary units. Days were systematically sampled, and within each sampled day, two 3-hour periods were randomly selected from the six possible periods. During each sampled period, anglers were interviewed as they exited the fishery through a sampled location. Thus, all interviews were of completed-trip anglers. All anglers exiting an access location during a sampled period were counted and as many as possible were interviewed for harvest and effort data by area fished (river or confluence area). Anglers exiting a location during a sampled period and not interviewed were prorated as river or confluence anglers based on proportions determined from anglers that were interviewed. Count and interview data were then expanded for each stratum to account for area-specific harvest and effort during periods and days that were not sampled. Because the age distribution of sockeye salmon changed over time, the data were post-stratified into three temporal components (Table 1).

Harvest and effort were estimated for each temporal stratum of the fishery. On day i and sample period j, m_{kij} completed anglers were interviewed as they exited location k and a_{kij} anglers were "missed" because they exited and were counted but were not interviewed. Interviewed anglers were assigned to one of three groups:

m_{1kij} = anglers that fished the river area only;

m_{2kij} = anglers that fished the confluence area only; or,

m_{3kij} = anglers that fished both areas; and,

$$m_{kij} = m_{1kij} + m_{2kij} + m_{3kij}. \quad (1)$$

Area-specific harvest of missed anglers (a_{kij}) was prorated based on information obtained from interviews. The proportion of missed anglers that fished the river was estimated as:

$$\hat{P}_{rkij} = \frac{m_{rkij}}{m_{kij}}, \quad (2)$$

where:

m_{rkij} = the number of interviewed anglers fishing the river = $m_{1kij} + m_{3kij}$.

Table 1. Temporal components of the recreational harvest and escapement sampled for age composition during the late run of sockeye salmon to the Russian River, 1992.

Return Component	Temporal Delineation
Confluence area harvest	7/20 - 7/31 8/01 - 8/10 8/11 - 8/18
River area harvest	7/20 - 7/31 8/01 - 8/10 8/11 - 8/18
Escapement through weir	7/26 - 7/31 8/01 - 8/10 8/11 - 8/20 8/21 - 9/14
Escapement spawning between falls and confluence	8/24, 9/01[a]

[a] Escapement not stratified; dates listed are sampling dates.

The number (a_{rkij}) of missed anglers prorated as fishing the river was estimated as:

$$\hat{a}_{rkij} = (a_{kij})\ (\hat{P}_{rkij}). \tag{3}$$

The total number of anglers fishing the river area and exiting the fishery at location k on day i during sample period j was estimated as:

$$\hat{M}_{rkij} = m_{rkij} + \hat{a}_{rkij}. \tag{4}$$

The same procedure was used to prorate the missed anglers who fished the confluence area:

$$\hat{M}_{ckij} = m_{ckij} + \hat{a}_{ckij}. \tag{5}$$

The mean river area harvest per interviewed angler was:

$$\bar{h}_{rkij} = \frac{\sum_{l=1}^{m_{rkij}} h_{rkijl}}{m_{rkij}} \tag{6}$$

where:

h_{rkijl} = the river area harvest of angler l at location k on day i during sample period j.

The variance of river area harvest among interviewed anglers was estimated as:

$$\hat{S}^2_{rkij} = \frac{\sum_{l=1}^{m_{rkij}} (h_{rkijl} - \bar{h}_{rkij})^2}{m_{rkij}-1}. \tag{7}$$

The total river area harvest of anglers exiting through access location k on day i during sample period j ($\hat{H}_{rkij}$) was estimated as:

$$\hat{H}_{rkij} = \hat{M}_{rkij}\ \bar{h}_{rkij}. \tag{8}$$

The mean river area harvest per period ($\bar{H}_{rki}$) at location k on day i was estimated as:

$$\hat{\bar{H}}_{rki} = \frac{\sum_{j=1}^{u} \hat{H}_{rkij}}{u} \tag{9}$$

where:

u = the number of periods sampled on day i (u = 2), and the variance among sample periods was estimated as:

$$\hat{S}^2_{rki} = \frac{\sum_{j=1}^{u} (\hat{H}_{rkij} - \hat{\bar{H}}_{rki})^2}{u - 1}. \quad (10)$$

The total river area harvest of anglers exiting access location k on day i was estimated by expanding the mean river area harvest per period on day i by:

$$\hat{H}_{rki} = U \hat{\bar{H}}_{rki} \quad (11)$$

where:

U = the total number of periods in a day (U = 6).

The mean river area harvest per day ($\bar{H}_{rk}$) at location k was estimated as:

$$\hat{\bar{H}}_{rk} = \frac{\sum_{i=1}^{d} \hat{H}_{rki}}{d} \quad (12)$$

where:

d = the number of days sampled.

The variance of river area harvest among days ($\hat{S}^2_{rk}$) at location k was estimated using the variance for a systematic sample (Wolter 1985) as:

$$\hat{S}^2_{rk} = \frac{\sum_{i=2}^{d} (\hat{H}_{(i)} - \hat{H}_{(i-1)})^2}{2(d-1)}. \quad (13)$$

The total river area harvest at location k ($\hat{H}_{rk}$) was estimated by expanding the mean harvest per day by:

$$\hat{H}_{rk} = D \hat{\bar{H}}_{rk} \quad (14)$$

where:

D = the total number of days during a time stratum.

The variance of the total river area harvest at location k was estimated as:

$$\hat{V}(H_{rk}) = (1-f_1)\, D^2_{rk}\, \frac{\hat{S}^2_{rk}}{d} + D_{rk}\, \frac{U^2}{u}\, (1-f_2)\, \frac{\sum_{i=1}^{d} \hat{S}^2_{rki}}{d}$$

$$+ D_{rk}\, U \sum_{i=1}^{d} \sum_{j=1}^{u} M^2_{rkij}\, (1-f_{3rkij})\, \frac{\hat{S}^2_{rkij}}{d\, u\, m_{rkij}} \qquad (15)$$

where:

D_{rk} = the total number of sampling days at location k during a time stratum;

f_1 = the finite population correction factor for days (d_{rk}/D_{rk});

f_2 = the finite population correction factor for periods (u_{rki}/U_{rki});

f_{3rkij} = the finite population correction factor for anglers (m_{rkij}/M_{rkij}).

There was a component of variance in the third stage (among anglers) due to the prorating of missed anglers that was not included. However, this component accounted for a small (0%-2%) percentage of variability for both total harvest and effort estimates of all strata in 1990 and 1991 (Carlon et al. 1991, Marsh 1992).

These procedures (Equations 2 through 15) were also used to estimate the confluence area harvest of anglers exiting each access location. Likewise, the same procedures were used to estimate effort (in angler-hours) expended in the river area and the confluence area by substituting the area-specific hours of effort reported by interviewed anglers for the reported harvest in Equations 2 through 15.

Total estimates of harvest and effort were determined for the late run by summing the individual stratum estimates. Stratum estimates were assumed to be independent and the variances of the total estimates were calculated as the sum of the variances of the individual stratum estimates.

Daily harvest rates were estimated for inseason management as an indicator of sockeye salmon abundance. The daily confluence area harvest rate was based solely on confluence effort and harvest reported by interviewed anglers. The mean daily harvest rate of the confluence area was estimated as:

$$\overline{HPUE_c} = (1/n) \sum_{l=1}^{n} HPUE_l \qquad (16)$$

where:

n = number of interviewed anglers reporting confluence-area effort; and,

$HPUE_l$ = confluence-area harvest per hour of effort for angler l.

The variance of this estimate was calculated as:

$$V(HPUE_c) = \frac{\sum_{l=1}^{n} (HPUE_l - \overline{HPUE_c})^2}{n(n-1)}. \quad (17)$$

The same procedure was used to estimate river-area harvest rates (HPUEr).

The overall harvest rate for the late run was historically estimated to provide a general basis for comparing seasonal fishing success among years (Nelson 1985, Hammarstrom and Athons 1989). A harvest rate for the late run was estimated by dividing the total harvest estimate by the total effort estimate. The associated variance was then calculated as the variance of a quotient of two random variables.

Spawning Escapement:

The escapement of spawning sockeye salmon to the Russian River drainage was enumerated at the stationary weir at the outlet of Lower Russian Lake. An adjustable gate system allowed fish to pass individually and be counted by the weir operator. The weir, which was also used to enumerate fish during the early run, was operational from 12 June to 14 September 1992. During the period of overlap of early and late runs (mid to late July), fish from each run were subjectively identified by degree of external sexual maturation (body color and kype development) and counted separately. Early in each run, sockeye salmon adults have not yet developed the reddish body coloration and large green head with hooked jaws that is characteristic of more sexually mature fish passing through the weir later in each run. Therefore, during the period of run overlap at the weir, the last of the early-run fish typically exhibit the reddish body coloration and green heads while the late-run fish have not yet developed these body characteristics. The period of overlap began on 17 July when late-run fish were intermixed with mature, early-run fish and continued through 26 July, after which early-run fish were no longer present.

Biological Data:

Eleven time and area strata were sampled for biological data to estimate the age, sex, and length composition of the late run (Table 1). Differences in age composition over time among spatial components have been demonstrated in the past (Carlon and Vincent-Lang 1990, Carlon et al. 1991, Marsh 1992).

Scales were collected from the preferred area of each sampled fish and placed on adhesive-coated cards (Clutter and Whitesel 1956). The sex and length (measured from the mid-eye to the fork-of-tail to the nearest millimeter) of each sampled fish was also determined and recorded. Scale impressions were

made in clear acetate and examined with a microfiche reader for aging. The European method of age description was used to record ages: the numeral preceding the decimal represents the number of freshwater annuli and the numeral following the decimal represents the number of marine annuli. Total age from brood is therefore the sum of the two numbers plus one.

In prior years, the late-run river area harvest was not sampled for age composition. The age composition from the confluence area harvest was used to allocate the river area harvest (Nelson et al. 1986, Carlon and Vincent-Lang 1990). This procedure assumes that the age composition of the confluence harvest represents that of the river area; however, significant differences in age composition were found among the three sampled areas (Carlon et al. 1991, Marsh 1992). In 1992 each area was sampled individually. Chi-square tests were used to test the null hypotheses of equal age compositions among locations and time strata. These tests were rejected if calculated tail-area probabilities (P values) were less than 0.10.

Age and sex composition of each run was estimated for each spatial/temporal stratum (i.e., confluence, river, and weir). The proportion of fish of age-sex group g in spatial/temporal stratum f, e.g., confluence harvest 7/20-7/31, was estimated as:

$$\hat{P}_{gf} = n_{gf}/n_f \tag{18}$$

where:

n_{gf} = the number of legible scales read from sockeye salmon sampled during stratum f and interpreted as age-sex g, and

n_f = the total number of legible scales read from sockeye salmon sampled during stratum f.

The variance of $\hat{P}_{gf}$ was estimated as (Scheaffer et al. 1978):

$$\hat{V}(P_{gf}) = \hat{P}_{gf}(1-\hat{P}_{gf})/(n_f-1). \tag{19}$$

The spatial/temporal estimates of the late-run sport harvest (H_{Tf}) were also apportioned by age group for each sex:

$$\hat{N}_{gf} = \hat{H}_{Tf}\hat{P}_{gf}, \tag{20}$$

where:

$\hat{H}_{Tf}$ = the estimated total harvest of sockeye salmon during spatial/temporal stratum f.

The variance of $\hat{N}_{gf}$ was estimated as (Goodman 1960):

$$\hat{V}(N_{gf}) = \hat{H}^2_{Tf}\,\hat{V}(P_{gf}) + \hat{P}^2_{gf}\,\hat{V}(H_{Tf}) - \hat{V}(P_{gf})\,\hat{V}(H_{Tf}), \tag{21}$$

where:

$\hat{V}(H_{Tf})$ = the variance of the harvest estimate during spatial/temporal stratum f.

Overall age composition by sex was estimated for the total late-run harvest by summing estimated number harvested by age over the spatial/temporal strata. The total number of fish harvested of sex and age g (N_g) was estimated as:

$$\hat{N}_g = \sum_{f=1}^{t} \hat{N}_{gf}, \tag{22}$$

where:

t = the number of spatial/temporal strata during the late run.

The variance of the estimate was calculated by summing the variances of the individual stratum estimates as:

$$\hat{V}(N_g) = \sum_{f=1}^{t} \hat{V}(N_{gf}). \tag{23}$$

The proportion of adults of sex and age g in the total sport harvest from the late run (P_g) was estimated as:

$$\hat{P}_g = \hat{N}_g/\hat{H}, \tag{24}$$

where:

$\hat{H}$ = the estimated total harvest of sockeye salmon from the late run.

The variance of $\hat{P}_g$ was estimated as the variance of the quotient of two random variables as:

$$\hat{V}(P_g) = \hat{P}^2_g \, [\hat{V}(N_g)/\hat{N}^2_g + \hat{V}(H)/\hat{H}^2] - 2\hat{V}(N_g)/\hat{N}_g \, \hat{H}] \tag{25}$$

where:

$\hat{V}(H)$ = the variance of the estimated harvest of fish from the late run as defined previously.

The number of sockeye salmon of sex and age group g in the escapement was estimated for each spatial/temporal stratum f using the estimated proportions (P_{gf}) as defined previously:

$$\hat{N}_{gf} = \hat{N}_{Tf}\hat{P}_{gf}, \tag{26}$$

where:

N_{Tf} = the total number of sockeye salmon enumerated during stratum f at the weir or spawning downstream from the falls.

The variance of $\hat{N}_{gf}$ was estimated as:

$$V(\hat{N}_{gf}) = N^2_{Tf}\, V(\hat{P}_{gf}). \quad (27)$$

Overall sex and age composition estimates of the escapement were generated for the late run by summing estimated numbers by sex and age over temporal strata. For the late run, the total number of spawning fish of age-sex g (N_g) was estimated as:

$$\hat{N}_g = \sum_{f=1}^{t} N_{gf}. \quad (28)$$

The variance of $\hat{N}_g$ was estimated as the sum of the variances of the individual estimates as:

$$V(\hat{N}_g) = \sum_{f=1}^{t} V(\hat{N}_{gf}). \quad (29)$$

The proportion of adults of sex and age g in the total escapement of the late run (P_g) was estimated as:

$$\hat{P}_g = \hat{N}_g/E, \quad (30)$$

where E = the total escapement of the late run enumerated at the weir or spawning downstream of the falls.

The variance of $\hat{P}_g$ was estimated by:

$$V(\hat{P}_g) = (1/E)^2\, V(\hat{N}_g). \quad (31)$$

Mean length at age was estimated by sex for each spatial/temporal stratum of the return: the confluence area harvest, the river harvest, and the weir escapement. To determine if individual spatial/temporal samples could be pooled to estimate overall mean length at age by sex, an analysis of variance (ANOVA) and Tukey's studentized multiple range test were utilized. The null hypothesis of no difference in mean length at age was rejected if the calculated tail-area probabilities (P values) were less than 0.05. This analysis was performed only for age-2.2 and -2.3 fish due to insufficient samples in the remaining age groups.

RESULTS

Creel Statistics

Survey Interviews:

Sampling at access locations began on 20 July. Sampling of two of the three major access locations continued until 18 August, just 2 days before the normal regulatory closure date. The third access location (ferry) discontinued operation on 16 August when ticket sales dropped below an acceptable level for the concessionaire.

The temporal demarcation point marking the beginning of the late run was determined by the appearance of fresh ocean-bright sockeye salmon in the confluence area of the fishery. Prior to the arrival of these late-run fish, the sport fishery was characteristically slow with reddish colored, maturing fish dominating the small harvest. The few remaining early-run fish all showed signs of prespawning sexual maturity.

A total of 2,861 anglers were counted as they exited sampled access locations during the 1992 late-run survey (Table 2). Of these, 2,060 (72.0%) were interviewed and 801 (28.0%) were not interviewed. The total number of interviews collected in the late run represents a 26.2% increase from 1991 (Marsh 1992). Most of the interviews (53.0%) were obtained from the ferry access location as this location was sampled most intensely and typically accounts for the most effort (Appendix A1).

Anglers exiting via the ferry location fished the confluence area exclusively (99%) during the late run (Appendix A2). Campground access locations were used to fish both areas. However, the majority of anglers exiting the Grayling access site fished the confluence area (66%), while the majority of anglers who exited at Pink Salmon fished the river area (79%).

Harvest and Effort:

Anglers exiting the ferry location accounted for most of the harvest (57%) and the corresponding effort (52%) during the late run (Table 3). The relative precisions of the late-run harvest and effort estimates were 16% and 13%, respectively (Table 3). Estimates of harvest, effort, and variances are presented by stratum (temporal component/access location) in Appendix A3.

The 1992 late-run harvest estimate was 26,101 (SE = 2,111) sockeye salmon (Table 4). The effort estimate for the late run was 87,918 (SE = 5,788) angler-hours. During the late run, 84% of the harvest was taken from the confluence area and the remaining 16% was taken from the river area (Table 4, Figure 3). Correspondingly, the effort during the late-run sport fishery was directed primarily at the confluence area (82%) and less so at the river area (18%).

The estimated HPUE for the late run was 0.297 (Table 5), a 25.6% decline in angler catch efficiency from 1991 (Marsh 1992).

Table 2. Summary of the number of interviews collected during sampled periods for the Russian River creel survey during the late run, 1992.

Exit Location	Area Fished			Total Interviews	Anglers Exiting and not Interviewed	Total Anglers Exiting
	Confluence	River	Both			
Ferry	1,082	7	0	1,089	619	1,708
Grayling	507	261	46	768	164	932
Pink Salmon	42	161	11	203	18	221
Late-Run Total	1,631	429	57	2,060	801	2,861

Table 3. Estimates of harvest, effort, and associated variances by access location for the late-run Russian River sockeye salmon recreational fishery, 1992.

Location	Harvest	(%)	Variance of Harvest	(%)	Relative[a] Precision (%)	Effort (Angler Hours)	(%)	Variance of Effort	(%)	Relative[a] Precision (%)
Ferry	14,827	57%	2,505,929	56%	21%	45,738	52%	19,019,824	57%	19%
Grayling	9,654	37%	1,783,828	40%	27%	34,057	39%	11,224,031	34%	19%
Pink Salmon	1,620	6%	165,917	4%	49%	8,123	9%	3,256,139	10%	44%
Total[b]	26,101	100%	4,455,674	100%	16%	87,918	100%	33,499,994	100%	13%

[a] alpha = 0.05

[b] Total percentages may not sum to 100 because of rounding error.

Table 4. Summary of estimated effort (angler-hours) and harvest of sockeye salmon during the late run, for each area of the Russian River recreational fishery, 1992.

Component	Confluence Area	River Area	Total	95% Confidence Interval
Effort (Angler-Hours)	71,784	16,134	87,918	76,574 - 99,263
SE	5,292	2,344	5,788	
Harvest	21,996	4,105	26,101	21,964 - 30,238
SE	2,033	569	2,111	

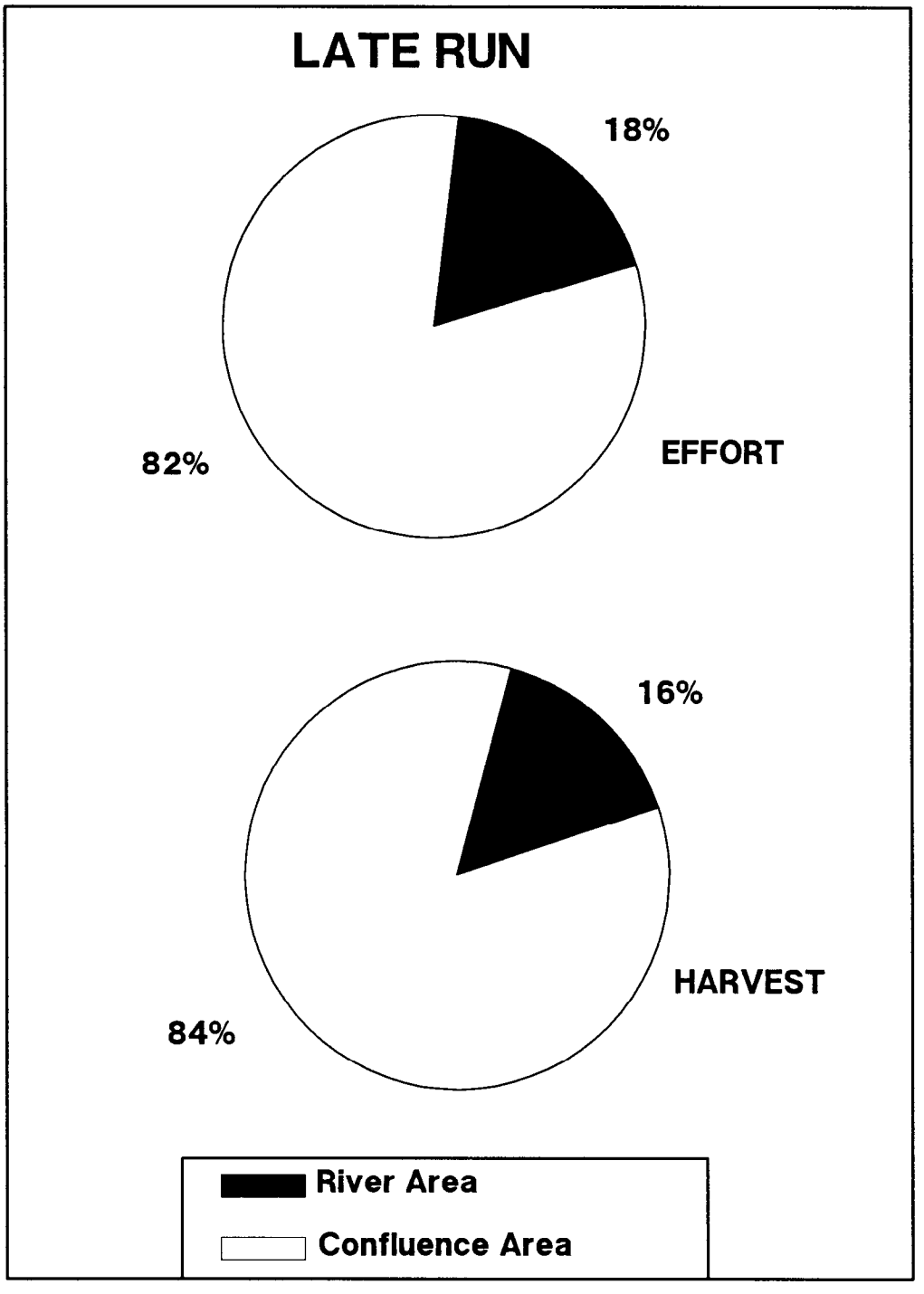

Figure 3. Harvest and angler effort by area for the Russian River late-run sockeye salmon recreational fishery, 1992.

Table 5. Estimated harvest per hour of angler effort (HPUE) by anglers interviewed during the late run, at each location, in the Russian River sockeye salmon recreational fishery, 1992.

Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Confluence	13	32	1,631	0.306	0.0008
River	13	32	429	0.254	0.0012
Both			2,060	0.297	0.0006

[a] Number of days on which at least one angler reported fishing effort.

[b] Number of days possible for conducting interviews.

[c] Anglers who fished both areas are represented twice.

Spawning Escapement

A total of 63,478 late-run sockeye salmon passed through the weir (Table 6, Appendix A4). The greatest daily counts at the weir occurred during the first week of August (Figure 4). Transition between the two runs occurred from 17 July to 26 July. Weir enumeration ceased on 14 September. An estimated 130 sockeye salmon holding approximately 100 m downstream from the weir were included in the 14 September total.

An estimated 4,980 sockeye salmon were counted during foot surveys of the Russian River downstream from the Russian River falls (Table 6).

The number of coho salmon enumerated through the weir during the late run was 1,315 (Table 6 and Appendix A4). This figure represents only a partial accounting of the total return as the weir was removed before the completion of the coho salmon migration.

Biological Data

The late-run escapement of sockeye salmon through the weir was comprised of three age groups: age 2.2 (85.2%), age 2.1 (11.4%), and age 2.3 (3.5%) (Table 7). Because there was no significant difference ($\chi^2 = 1.59$, df = 2, $P = 0.45$) in age composition between the third (11-20 August) and fourth (21 August-14 September) time strata, these samples were combined. There was a significant difference in the age composition among the three temporal strata ($\chi^2 = 57.29$, df = 4, $P < 0.001$). Age-2.2 and -2.3 fish dominated the first temporal stratum (81.7% and 17.6%, respectively). Age-2.2 fish were the dominant age class throughout the duration of the migration but age-2.3 fish declined to 1%-2% during subsequent time strata and age-2.1 fish increased from less than 1% to 17.6% later in the run.

The late-run harvest from the confluence area was comprised predominantly of age-2.2 (72.7%), age-2.3 (21.8%), and age-1.3 (5.1%) fish (Table 8). There were significant ($\chi^2 = 57.2$ df = 6, $P < 0.005$) temporal changes in the age composition. Consistent with the weir escapement, age 2.2 was the dominant age class throughout the return. The proportion of age-1.3 adults declined from 11.2% during the first time stratum to 2.6% during the final stratum while age-2.1 fish increased from 0% during the first two strata to 5.3% during the final stratum.

The late-run harvest from the river area was also primarily age-2.2 (85.1%) and age-2.3 (9.7%) fish (Table 9). Age-2.1 adults contributed 5.2% to the total river harvest. There were significant ($\chi^2 = 16.1$, df = 4, $P = 0.003$) temporal changes in the age distribution of the river harvest. The predominant age class in each temporal stratum was age-2.2 fish. The proportion of age-2.1 fish sampled in the river increased from 0% in the first time stratum to (10.3%) in the third stratum.

The age composition of sockeye salmon that spawned in the Russian River downstream from the Russian River falls was predominantly age-1.3 (68.4%) (Table 10). Ages-2.1 and -2.3 fish contributed 18.8% and 12.0%, respectively. Mean length by age and sex was also estimated for this spawning component of the late run (Table 11).

Table 6. Escapements of sockeye, coho, and chinook salmon during the late run to the Russian River drainage, 1992.

Component	Dates	Sockeye Salmon	Coho Salmon	Chinook Salmon
Late Run	07/17 - 09/14	63,478[a]	1,315[b]	15
Downstream[c]	08/24[d]	4,980[e]		31[f]

[a] From 7/17 through 7/26, early-run fish were differentiated from late-run fish based on the degree of external maturation (color).

[b] Only a partial count as the weir was removed prior to completion of migration.

[c] Fish that spawned downstream from the Russian River Falls.

[d] Two foot surveys (8/24 and 9/01) were made downstream from the Russian River falls. A greater number of fish were enumerated on 8/24 and the tabulated values are for that date only and represent a minimum estimate.

[e] 4,372 live fish and 608 dead fish that spawned downstream from the Russian River Falls.

[f] 14 live fish and 17 dead fish enumerated downstream from Russian River Falls.

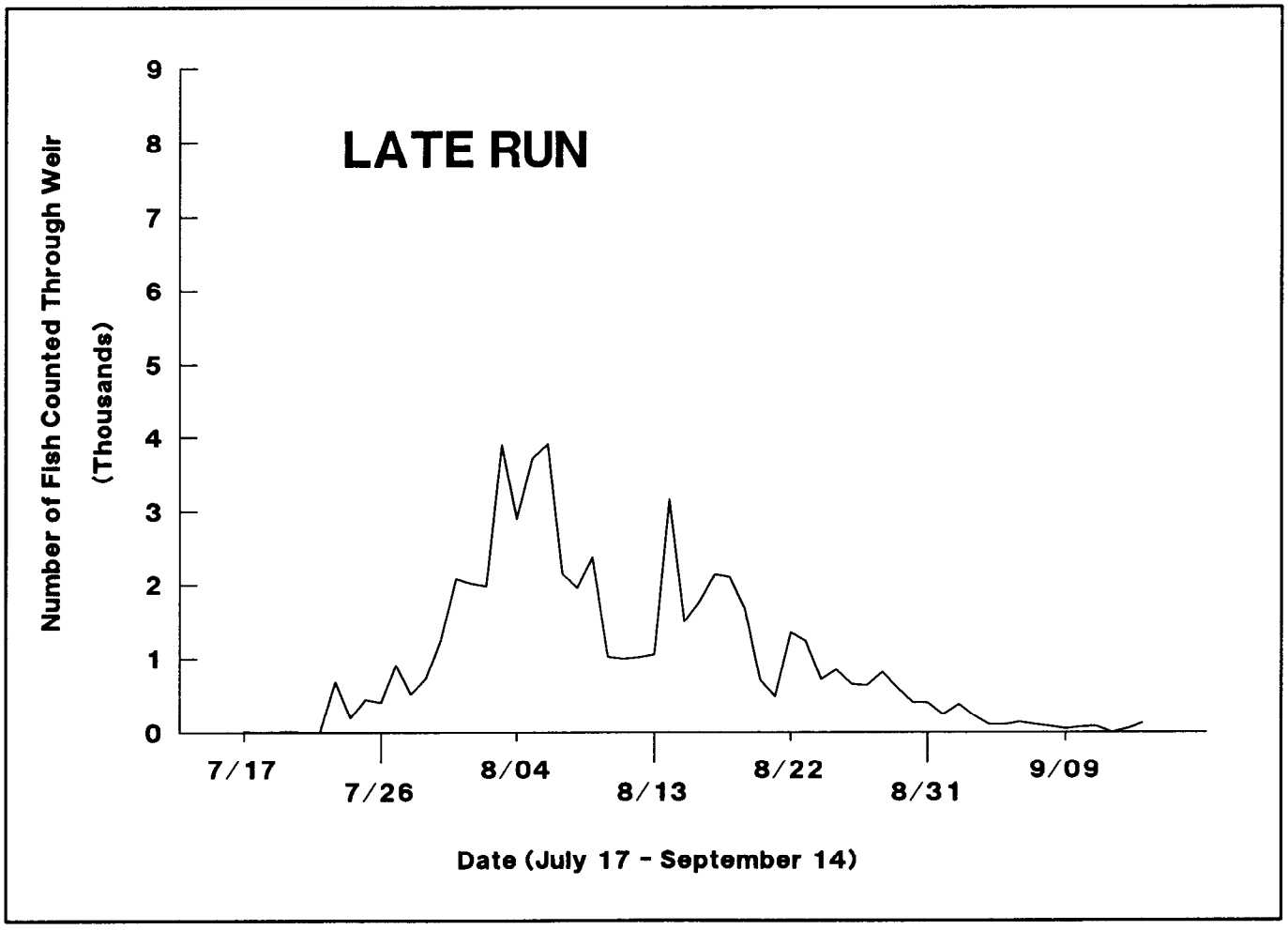

Figure 4. Daily escapement of sockeye salmon through the Russian River weir, 1992.

Table 7. Estimated age and sex composition of the late-run sockeye salmon escapement through the Russian River weir, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
7/20 - 7/31					
n^b = 153					
Count = 7,548					
Females					
Sample Size	19	0	67	0	86
Percent	12.4	0.0	43.8	0.0	56.2
Variance of Percent	7.2	0.0	16.2	0.0	16.2
Number	937	0	3,305	0	4,243
Variance of Number	40,766	0	92,259	0	92,259
Males					
Sample Size	8	0	58	1	67
Percent	5.2	0.0	37.9	0.7	43.8
Variance of Percent	3.3	0.0	15.5	0.4	16.2
Number	395	0	2,861	49	3,305
Variance of Number	18,574	0	88,224	2,434	92,259
Sexes Combined					
Sample Size	27	0	125	1	153
Percent	17.6	0.0	81.7	0.7	100.0
Variance of Percent	9.6	0.0	9.8	0.4	
Number	1,332	0	6,167	49	7,548
Variance of Number	54,472	0	56,041	2,434	

-continued-

Table 7. (Page 2 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
8/01 - 8/10					
n[b] = 92					
Count = 26,902					
Females					
Sample Size	1	0	65	0	66
Percent	1.1	0.0	70.7	0.0	71.7
Variance of Percent	1.2	0.0	22.8	0.0	22.3
Number	292	0	19,007	0	19,299
Variance of Number	85,505	0	1,649,032	0	1,612,387
Males					
Sample Size	0	0	19	7	26
Percent	0.0	0.0	20.7	7.6	28.3
Variance of Percent	0.0	0.0	18.0	7.7	22.3
Number	0	0	5,556	2,047	7,603
Variance of Number	0	0	1,303,252	559,074	1,612,387
Sexes Combined					
Sample Size	1	0	84	7	92
Percent	1.1	0.0	91.3	7.6	100.0
Variance of Percent	1.2	0.0	8.7	7.7	
Number	292	0	24,563	2,047	26,902
Variance of Number	85,505	0	631,424	559,074	

-continued-

Table 7. (Page 3 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
8/21 - 9/14					
n^b = 153 Count = 29,028					
Females					
Sample Size	2	0	93	2	97
Percent	1.3	0.0	60.8	1.3	63.4
Variance of Percent	0.8	0.0	15.7	0.8	15.3
Number	379	0	17,644	379	18,403
Variance of Number	71,518	0	1,321,423	71,518	1,286,375
Males					
Sample Size	1	0	30	25	56
Percent	0.7	0.0	19.6	16.3	36.6
Variance of Percent	0.4	0.0	10.4	9.0	15.3
Number	190	0	5,692	4,743	10,625
Variance of Number	35,996	0	873,844	757,806	1,286,375
Sexes Combined					
Sample Size	3	0	123	27	153
Percent	2.0	0.0	80.4	17.6	100.0
Variance of Percent	1.3	0.0	10.4	9.6	
Number	569	0	23,336	5,123	29,028
Variance of Number	106,566	0	873,844	805,642	

-continued-

Table 7. (Page 4 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
Late Run Total 7/26 - 9/14					
n^b = 398 Count = 63,478					
Females					
Percent	2.5	0.0	62.9	0.6	66.1
Variance of Percent	0.5	0.0	7.6	0.2	7.4
Number	1,609	0	39,957	379	41,945
Variance of Number	197,789	0	3,062,715	71,518	2,991,022
Males					
Percent	0.9	0.0	22.2	10.8	33.9
Variance of Percent	0.1	0.0	5.6	3.3	7.4
Number	584	0	14,109	6,839	21,533
Variance of Number	54,569	0	2,265,321	1,319,313	2,991,022
Sexes Combined					
Percent	3.5	0.0	85.2	11.4	100
Variance of Percent	0.6	0.0	3.9	3.4	
Number	2,194	0	54,066	7,219	63,478
Variance of Number	246,544	0	1,561,310	1,367,149	

[a] Percents and Numbers may not sum to Total because of rounding error.
[b] n = sample size.

Table 8. Estimated age and sex composition of late-run sockeye salmon harvested in the confluence area of the Russian River recreational fishery, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
7/20 - 7/31					
n[b]= 143					
Harvest= 9,494					
Var(Harvest)= 2,794,878					
Sample Size	28	12	44	0	84
Percent	19.6	8.4	30.8	0.0	58.7
Variance of Percent	11.1	5.4	15.0	0.0	17.1
Number	1,859	797	2,921	0	5,577
Variance of Number	204,007	66,965	395,626	0	1,113,452
Sample Size	21	4	34	0	59
Percent	14.7	2.8	23.8	0.0	41.3
Variance of Percent	8.8	1.9	12.8	0.0	17.1
Number	1,394	266	2,257	0	3,917
Variance of Number	137,335	18,911	269,468	0	624,837
Sample Size	49	16	78	0	143
Percent	34.3	11.2	54.5	0.0	100.0
Variance of Percent	15.9	7.0	17.5	0.0	
Number	3,253	1,062	5,179	0	9,494
Variance of Number	466,700	96,109	984,033	0	2,794,878

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Table 8. (Page 2 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
8/01 - 8/10					
n[b]= 37					
Harvest= 10,582					
Var(Harvest)= 1,210,963					
Females					
Sample Size	1	0	23	0	24
Percent	2.7	0.0	62.2	0.0	64.9
Variance of Percent	7.3	0.0	65.3	0.0	63.3
Number	286	0	6,578	0	6,864
Variance of Number	81,796	0	1,191,640	0	1,210,739
Males					
Sample Size	4	0	9	0	13
Percent	10.8	0.0	24.3	0.0	35.1
Variance of Percent	26.8	0.0	51.1	0.0	63.3
Number	1,144	0	2,574	0	3,718
Variance of Number	310,828	0	638,029	0	850,723
Sexes Combined					
Sample Size	5	0	32	0	37
Percent	13.5	0.0	86.5	0.0	100.0
Variance of Percent	32.5	0.0	32.5	0.0	
Number	1,430	0	9,152	0	10,582
Variance of Number	381,720	0	1,265,396	0	1,210,963

-continued-

Table 8. (Page 3 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
8/11 - 8/20					
n[b]= 114					
Harvest= 1,920					
Var(Harvest)= 126,147					
Females					
Sample Size	4	2	66	3	75
Percent	3.5	1.8	57.9	2.6	65.8
Variance of Percent	3.0	1.5	21.6	2.3	19.9
Number	67	34	1,112	51	1,263
Variance of Number	1,222	582	49,962	895	61,691
Males					
Sample Size	2	1	33	3	39
Percent	1.8	0.9	28.9	2.6	34.2
Variance of Percent	1.5	0.8	18.2	2.3	19.9
Number	34	17	556	51	657
Variance of Number	582	284	17,051	895	21,855
Sexes Combined					
Sample Size	6	3	99	6	114
Percent	5.3	2.6	86.8	5.3	100.0
Variance of Percent	4.4	2.3	10.1	4.4	
Number	101	51	1,667	101	1,920
Variance of Number	1,920	895	98,735	1,920	126,147

-continued-

Table 8. (Page 4 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
Late Run Total					
n[b]= 294					
Harvest= 21,996					
Var(Harvest)= 4,131,988					
Females					
Percent	10.1	3.8	48.2	0.2	62.3
Variance of Percent	5.6	1.4	21.1	0.0	21.0
Number	2,212	830	10,611	51	13,704
Variance of Number	287,025	67,547	1,637,229	895	2,385,882
Males					
Percent	11.7	1.3	24.5	0.2	37.7
Variance of Percent	8.3	0.4	14.9	0.0	19.8
Number	2,572	282	5,387	51	8,292
Variance of Number	448,746	19,194	924,549	895	1,497,415
Sexes Combined					
Percent	21.8	5.1	72.7	0.5	100.0
Variance of Percent	14.0	2.0	23.1	0.0	
Number	4,784	1,113	15,998	101	21,996
Variance of Number	850,341	97,003	2,348,163	1,920	4,131,988

[a] Percents and Numbers may not sum to Total because of rounding error.
[b] n = sample size.

Table 9. Estimated age and sex composition of late-run sockeye salmon harvested in the river area of the Russian River recreational fishery, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
7/20 - 7/31					
n[b]= 32					
Harvest= 651					
Var(Harvest)= 37,132					
Sample Size	3	0	14	0	17
Percent	9.4	0.0	43.8	0.0	53.1
Variance of Percent	27.4	0.0	79.4	0.0	80.3
Number	61	0	285	0	346
Variance of Number	1,386	0	10,177	0	13,586
Sample Size	5	0	10	0	15
Percent	15.6	0.0	31.3	0.0	46.9
Variance of Percent	42.5	0.0	69.3	0.0	80.3
Number	102	0	203	0	305
Variance of Number	2,551	0	6,306	0	11,265
Sample Size	8	0	24	0	32
Percent	25.0	0.0	75.0	0.0	100.0
Variance of Percent	60.5	0.0	60.5	0.0	
Number	163	0	488	0	651
Variance of Number	4,659	0	23,225	0	37,132

-continued-

Table 9. (Page 2 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
8/01 - 8/10					
n[b]= 61					
Harvest= 2,017					
Var(Harvest)= 100,801					
Females					
Sample Size	2	0	46	2	50
Percent	3.3	0.0	75.4	3.3	82.0
Variance of Percent	5.3	0.0	30.9	5.3	24.6
Number	66	0	1,521	66	1,653
Variance of Number	2,205	0	69,584	2,205	77,498
Males					
Sample Size	2	0	9	0	11
Percent	3.3	0.0	14.8	0.0	18.0
Variance of Percent	5.3	0.0	21.0	0.0	24.6
Number	66	0	298	0	364
Variance of Number	2,205	0	10,511	0	13,052
Sexes Combined					
Sample Size	4	0	55	2	61
Percent	6.6	0.0	90.2	3.3	100.0
Variance of Percent	10.2	0.0	14.8	5.3	
Number	132	0	1,819	66	2,017
Variance of Number	4,485	0	87,811	2,205	100,801

-continued-

Table 9. (Page 3 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
8/11 - 8/20					
n[b]= 155					
Harvest= 1,437					
Var(Harvest)= 185,753					
Females					
Sample Size	6	0	87	3	96
Percent	3.9	0.0	56.1	1.9	61.9
Variance of Percent	2.4	0.0	16.0	1.2	15.3
Number	56	0	807	28	890
Variance of Number	732	0	61,526	301	74,132
Males					
Sample Size	5	0	41	13	59
Percent	3.2	0.0	26.5	8.4	38.1
Variance of Percent	2.0	0.0	12.6	5.0	15.3
Number	46	0	380	121	547
Variance of Number	574	0	15,371	2,244	29,791
Sexes Combined					
Sample Size	11	0	128	16	155
Percent	7.1	0.0	82.6	10.3	100.0
Variance of Percent	4.3	0.0	9.3	6.0	
Number	102	0	1,187	148	1,437
Variance of Number	1,740	0	128,431	3,109	185,753

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Table 9. (Page 4 of 4).

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
Late Run Total					
n[b]= 248					
Harvest= 4,105					
Var(Harvest)= 323,686					
Females					
Percent	4.5	0.0	63.6	2.3	70.4
Variance of Percent	2.7		54.9	1.5	55.2
Number	183	0	2,612	94	2,889
Variance of Number	4,324	0	141,286	2,506	165,216
Males					
Percent	5.2	0.0	21.5	2.9	29.6
Variance of Percent	3.4		19.8	1.4	29.9
Number	214	0	881	121	1,216
Variance of Number	5,330	0	32,188	2,244	54,107
Sexes Combined					
Percent	9.7	0.0	85.1	5.2	100.0
Variance of Percent	7.0		39.4	3.3	
Number	397	0	3,494	214	4,105
Variance of Number	10,885	0	239,467	5,314	323,686

[a] Percents and Numbers may not sum to Total because of rounding error.
[b] n = sample size.

Table 10. Estimated age and sex composition of sockeye salmon which spawn downstream from the Russian River falls, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
7/26 - 8/06[b]					
n[c]= 133					
Count= 4,980					
Females					
Sample Size	5	49	1	19	74
Percent	3.8	36.8	0.8	14.3	55.6
Variance of Percent	2.7	17.6	0.6	9.3	18.7
Number	187	1,835	37	711	2,771
Variance of Number	6,798	43,718	1,402	23,006	46,373
Males					
Sample Size	11	42	0	6	59
Percent	8.3	31.6	0.0	4.5	44.4
Variance of Percent	5.7	16.4	0.0	3.3	18.7
Number	412	1,573	0	225	2,209
Variance of Number	14,254	40,595	0	8,094	46,373
Sexes Combined					
Percent	12.0	68.4	0.8	18.8	100.0
Variance of Percent	8.5	34.0	0.6	12.5	
Number	599	3,407	37	936	4,980
Variance of Number	21,052	84,313	1,402	31,099	

[a] Percents and Numbers may not sum to Total because of rounding error.
[b] Indicates two distinct sampling dates.
[c] n = sample size.

Table 11. Mean length (millimeters) at age, by sex, for sampled sockeye salmon which spawned below the falls area during the late run of sockeye salmon to the Russian River, 1992.

Component	Statistic	Age Class			
		2.3	2.2	1.2	1.3
Female	Mean Length	567	505	526	561
	SE	5.2		4.1	3.4
	Sample Size	5	1	19	49
Male	Mean Length	584		533	599
	SE	4.5		10.2	3.0
	Sample Size	11		6	42

Differences in mean length by age and sex were tested among sample locations and time strata to determine if samples could be pooled together. Fish aged 2.2 were significantly larger ($F = 8.78$, $df = 2$, $n = 706$, $P = 0.002$) at the confluence than at either the river or the weir, and those sampled during the first time stratum were significantly larger ($F = 15.10$, $df = 2$, $n = 706$, $P < 0.0001$) than those during the next two strata. Therefore, samples were stratified by location and time to estimate mean length by age and sex (Table 12).

Total Return Statistics

Overall, an estimated 89,579 late-run sockeye salmon returned to the Russian River in 1992 (Table 13). Of these, 82.1% were age 2.2 and 8.2% were age 2.3. Ages 2.1 and 1.3 comprised 8.4% and 1.2% of the return, respectively. Spawners below the falls were not included in this total. These fish, which are primarily 3-ocean fish, are more closely associated with the age structure of sockeye salmon spawning in the mainstem Kenai River (Cross et al. 1983, 1985, 1986) and are believed to spend their freshwater residency in Skilak Lake.

DISCUSSION

Relative Run Strength

Total return of the 1992 late run (harvest plus escapement) was below the historical (1976-1991) average of 116,276 (Figure 5). However, the 1992 late run continued to follow a general trend, beginning in 1978, of greater numbers of sockeye salmon returning to the Russian River system which surpass the long-term (1963-1977) average of 65,072 sockeye salmon.

Sample Design

Creel Survey:

An underlying assumption necessary for accurate harvest estimates is that most, if not all, anglers exit the fishery through one of the three sampled access locations. Although anglers left the fishery from other locations, these anglers comprised only a minor portion of the total fishery. Creel census personnel and the project leader informally monitored the other access sites at least two times a day and found that use was relatively minor.

Observations of angler activity during the unsampled hours of 0000 to 0600 hours indicated that, generally, only small numbers of anglers were fishing at those hours during 1992. An informal accounting of activity during these hours was accomplished through interviews with anglers and frequent queries of the campground and ferry employees. Additionally, the project staff observed the level of fishing effort before 0600 hours and after 0000 hours, as this generally involved a personal fishing trip. However, random observations of access locations during the nighttime period should be continued in the future. This will provide additional information regarding any possible changes in angler use patterns which might prove useful in further refining the survey.

Table 12. Mean length (millimeters) at age, by sex, for the late run of sockeye salmon sampled from the Russian River, 1992.

			Time Strata											
			7/20 - 31			8/01 - 10			8/11 - 20			8/21 - 9/13		
Area	Age	Sex	N[a]	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Confluence														
	1.3													
		Female	12	561	7.2				2	570	10.0			
		Male	4	573	18.0				1	600				
	2.1													
		Female							3	403	4.4			
		Male							3	397	9.3			
	2.2													
		Female	44	530	2.9	23	509	4.2	66	502	2.6			
		Male	34	519	5.1	9	512	12.9	33	503	4.2			
	2.3													
		Female	29	583	3.3	1	565		4	581	7.2			
		Male	21	586	4.5	4	578	21.8	2	575	5.0			
River	2.1													
		Female				2	383	32.5	3	445	33.0			
		Male							13	408	4.2			
	2.2													
		Female	14	517	6.1	46	507	3.4	87	507	2.3			
		Male	10	500	7.2	9	502	8.3	41	499	4.3			
	2.3													
		Female	3	563	10.1	2	540	15.0	6	570	5.4			
		Male	5	590	8.5	2	615	5.0	5	592	11.1			
Weir[b]	2.1													
		Female							2	423	2.5			
		Male	1	415		7	400	3.6	17	415	3.1	8	400	8.8
	2.2													
		Female	67	514	2.3	65	503	3.1	74	500	2.1	19	501	3.5
		Male	58	504	3.8	19	499	5.0	25	493	4.0	5	489	13.8
	2.3													
		Female	19	579	5.0	1	585		1	560		1	562	
		Male	8	592	9.7				1	562				

[a] N = Sample size.

[b] Fish that migrated through the weir.

Table 13. Estimated age and sex composition of the late run of sockeye salmon to the Russian River, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total[a]
7/20 - 8/20					
Late Run Total [b] n[c]= 941					
Number= 89,579					
Var(Harvest)= 4,455,674					
Females					
Percent	4.5	0.9	59.4	0.6	65.3
Variance of Percent	0.6	0.1	0.8	0.1	0.3
Number	4,004	830	53,180	524	58,538
Variance of Number	489,138	67,547	4,841,231	74,919	5,542,120
Males					
Percent	3.8	0.3	22.7	7.8	34.7
Variance of Percent	0.6	0.0	2.5	1.4	2.4
Number	3,371	282	20,377	7,010	31,041
Variance of Number	508,645	19,194	3,222,058	1,322,452	4,542,545
Sexes Combined					
Percent	8.2	1.2	82.1	8.4	100.0
Variance of Percent	1.2	0.1	0.4	1.5	
Number	7,375	1,113	73,557	7,534	89,579
Variance of Number	1,107,769	97,003	4,148,940	1,374,384	

[a] Percents and Numbers may not sum to Total because of rounding error.
[b] Confluence area harvest + river area harvest + escapement through the weir.
[c] n = Number sampled.

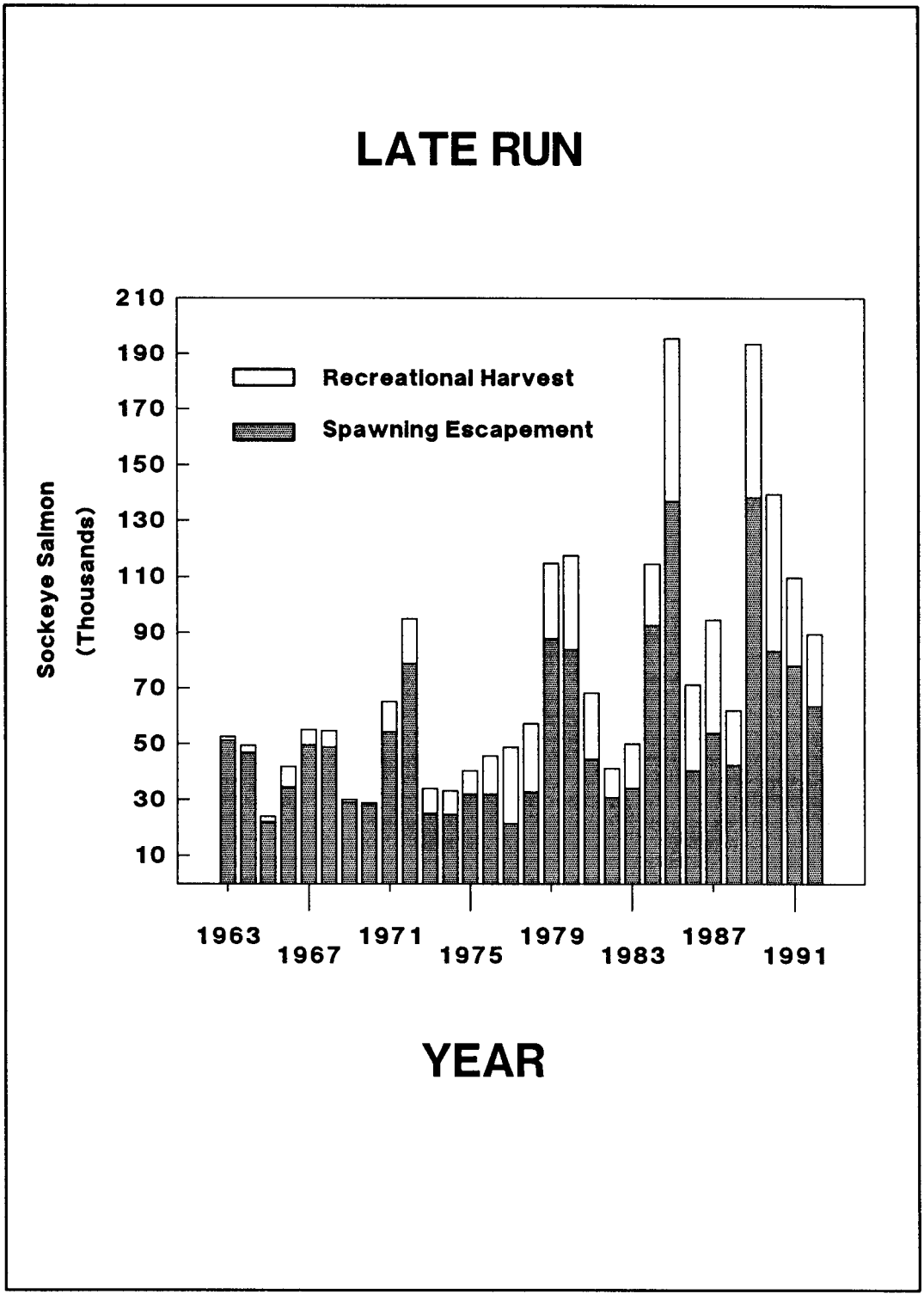

Figure 5. Historical returns of sockeye salmon for the late run to the Russian River.

Age Composition:

The accurate assessment of the age composition of the sockeye salmon return is needed to establish accurate brood tables for the Russian River system. The sampling of time and area components adopted in 1990 and 1991 was continued during the 1992 season. This increase in sampling intensity over prior years is an effort to achieve more accurate age composition estimates. Significant temporal changes in age composition were detected within spatial components as well as differences among spatial components within temporal strata since 1990 (Carlon et al. 1991, Marsh 1992).

Age composition of the confluence and river harvests and the weir escapement clearly differed during the late run in 1992. Because age compositions differed over time and among the spatial components of the fishery, samples could not be pooled together. A harvest estimate or escapement number of each time stratum was calculated for each spatial stratum. This harvest or escapement was then allocated based upon the sex and age proportions of each temporal/spatial stratum. This method provided an unbiased allocation of the estimated harvests or escapement from the different areas of the Russian River.

It is recommended that sampling of the temporal and spatial strata be continued at the present sampling intensity. This will improve estimates of the numbers of sockeye salmon returning by age and sex and the evaluation of differences over time. The end result will be improved accuracy of brood production information necessary for the long term management of the Russian River system.

Management of the Fishery

The utilization of migratory timing statistics from weir counts and fishery harvest rates should be continued (Vincent-Lang and Carlon 1991). The technique of fitting a migratory timing distribution function to count and harvest rate data has been used successfully in the Kenai River to project escapements of chinook salmon (McBride et al. 1989) and was adapted from techniques used to quantify migratory timing of chinook salmon in the Yukon River drainage (Mundy 1982). It is recommended that this technique continue to be implemented in 1993 and in subsequent years to further evaluate the value of these statistics in managing the Russian River sockeye salmon resource.

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Steve Hammarstrom provided consistent, critical advice relating to all aspects of the project which contributed greatly towards my understanding of the project and the fishery resource. Paul Zallek collected creel survey data and age, sex, and length data from the fishery and monitored the fishery for regulatory violations. His detailed observations of the fishery were vital to the conduct of the creel census and the management of the sockeye salmon resource. Colleen O'Brien also collected creel survey data and age, sex, and length data from the fishery. Her enthusiasm and conduct while performing her responsibilities proved to be an asset to the Russian River project. Jim Hasbrouck provided detailed statistical analyses necessary to allocate the age

compositions of the sport harvest and the escapement as well as much appreciated critical review. Sandy Sonnichsen wrote the creel census program code which calculates the effort and harvest statistics from the raw creel survey data. Jay Carlon provided indispensable technical support and data analysis review. Dave Athons assisted with vital logistical support and provided important suggestions about the day-to-day operations of the study. Dave Nelson provided valuable guidance and a long-term perspective towards achieving project objectives.

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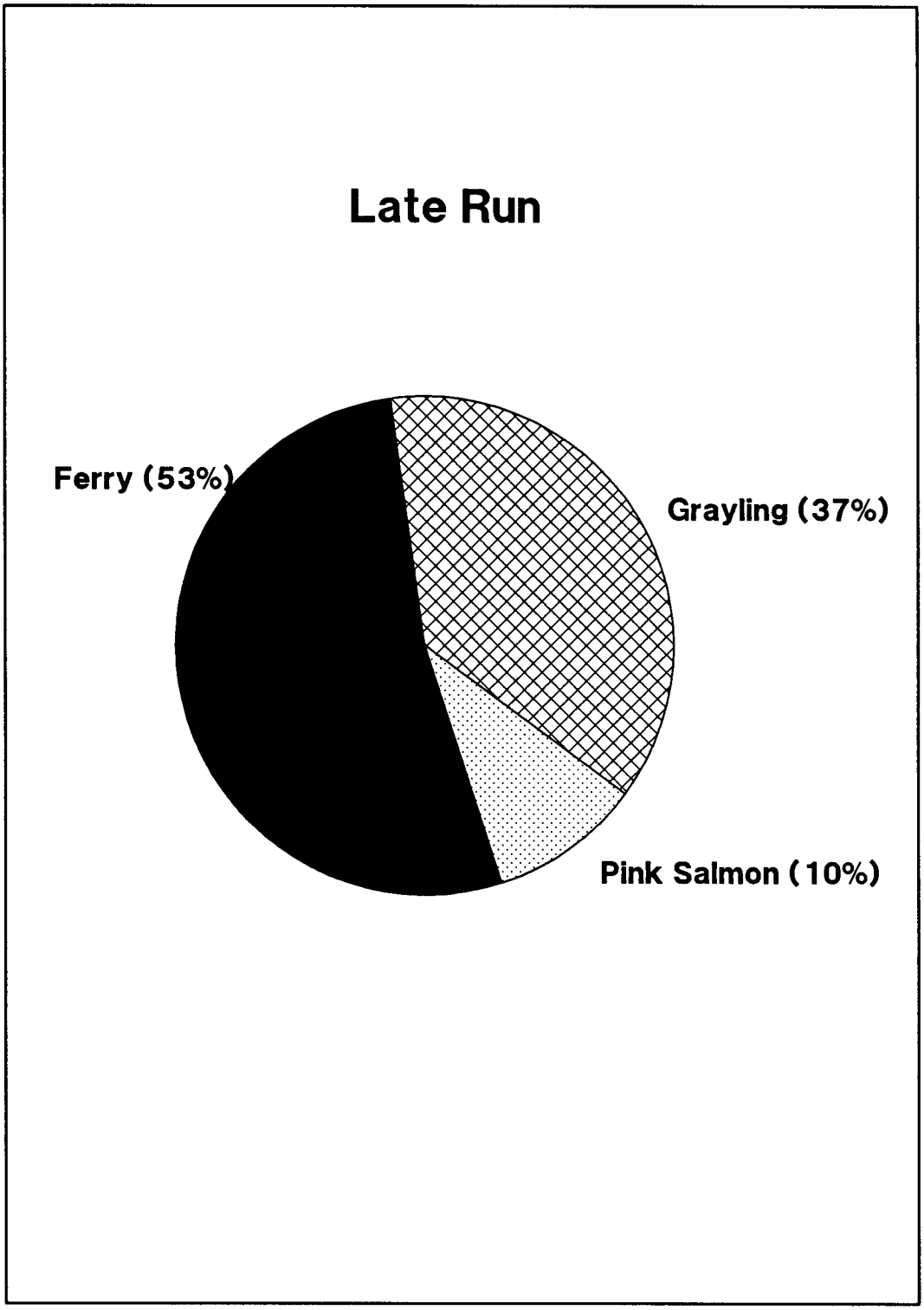
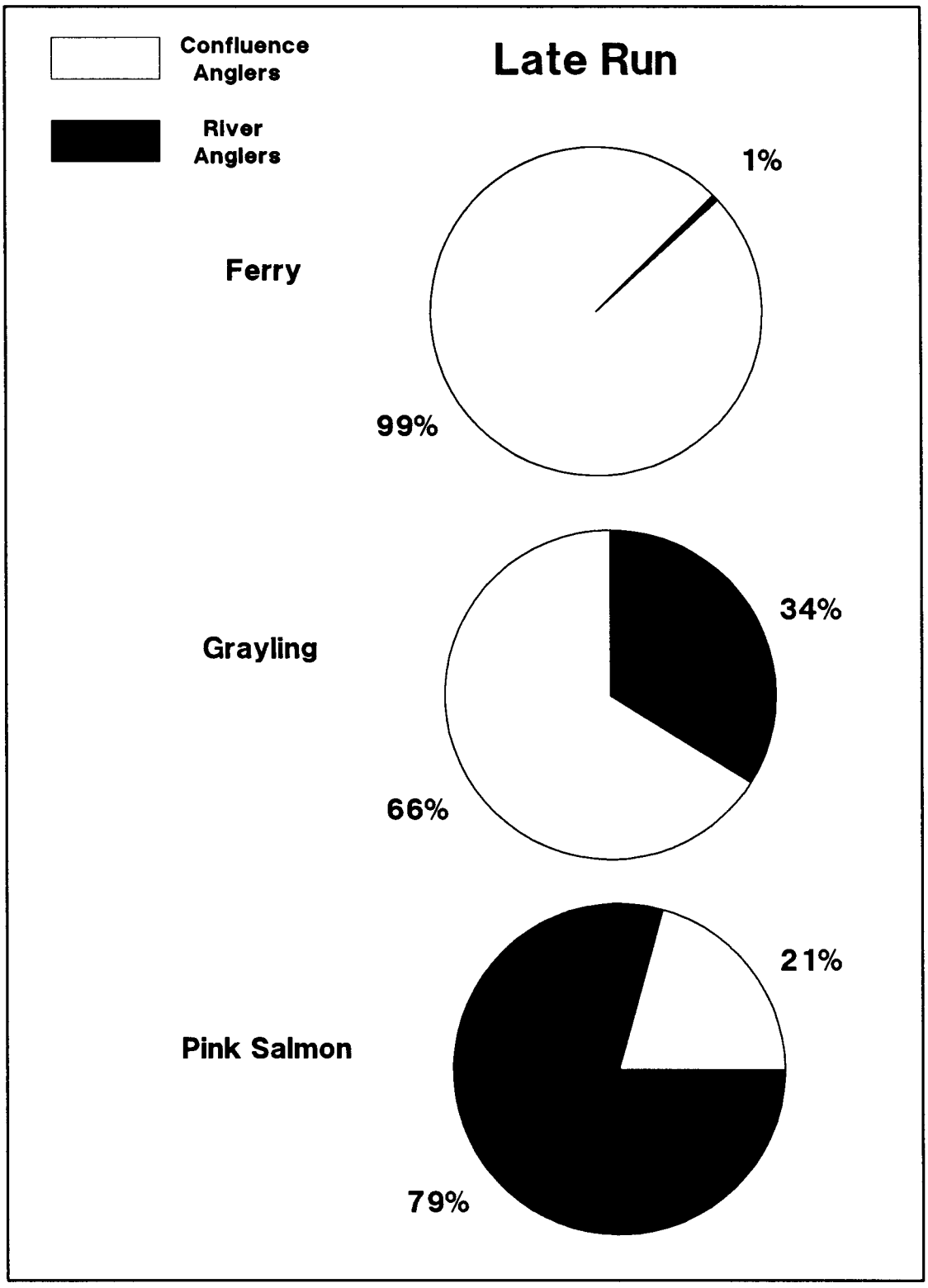
APPENDIX A

Selected Summaries of Fishery and Escapement Data
from the Russian River, 1992.



Appendix A1. Relative proportions of interviews collected at the three access locations to the Russian River late-run sockeye salmon recreational fishery, 1992.



Appendix A2. Relative proportions of confluence and river anglers interviewed during the Russian River creel survey by access location, late run, 1992.

Appendix A3. Temporal harvest and effort estimates for the 1992 Russian River late-run sockeye salmon recreational fishery by area and access location.[a]

Location Exited	Temporal Period	D[b]	d[c]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance Components: Days	%	Periods	%	Anglers	%
Late-run river effort:													
Ferry	7/20-7/31	12	5										
Grayling	7/20-7/31	12	3	207	19,692	2,484	743,028	708,896	95	33,520	5	613	0
Pink Salmon	7/20-7/31	12	3	70	2,631	836	102,243	94,698	93	7,387	7	159	0
	Total 7/20-7/31					3,320	845,271						
Ferry	8/01-8/10	10	6	26	4,682	255	31,227	31,212	100	0	0	15	0
Grayling	8/01-8/10	10	4	344	31,583	3,443	585,897	473,746	81	110,487	19	1,663	0
Pink Salmon	8/01-8/10	10	3	397	2,444	3,969	547,730	57,021	10	490,046	89	663	0
	Total 8/01-8/10					7,667	1,164,854						
Ferry	8/11-8/20	6	2										
Grayling	8/11-8/20	10	4	345	81,590	3,452	1,353,067	1,223,857	90	128,456	9	753	0
Pink Salmon	8/11-8/20	10	2	170	47,741	1,695	2,131,980	1,909,620	90	222,360	10	0	0
	Total 8/11-8/20					5,147	3,485,047						
	Late-run river					16,134	5,495,172						
Late-run confluence effort:													
Ferry	7/20-7/31	12	5	1,655	268,305	19,858	8,338,403	4,507,516	54	3,821,998	46	8,889	0
Grayling	7/20-7/31	12	3	1,348	141,865	16,182	5,299,807	5,107,146	96	190,258	4	2,404	0
Pink Salmon	7/20-7/31	12	3	75	9,242	903	399,547	332,703	83	66,815	17	29	0
	Total 7/20-7/31					36,943	14,037,757						
Ferry	8/01-8/10	10	6	2,257	586,945	22,566	9,768,395	3,912,967	40	5,835,015	60	20,414	0
Grayling	8/01-8/10	10	4	585	69,039	5,850	2,684,387	1,035,583	39	1,646,678	61	2,126	0
Pink Salmon	8/01-8/10	10	3	72	1,497	720	74,639	34,930	47	39,709	53	1	0
	Total 8/01-8/10					29,136	12,527,421						
Ferry	8/11-8/20	6	2	510	33,300	3,059	881,799	399,595	45	480,932	55	1,272	0
Grayling	8/11-8/20	10	4	265	24,693	2,647	557,845	370,395	66	187,146	34	304	0
Pink Salmon	8/11-8/20	10	2										
	Total 8/11-8/20					5,705	1,439,644						
	Late-run confluence					71,784	28,004,822						
	Late-run total					87,918	33,499,994						

-continued-

Appendix A3. (Page 2 of 2).

Location Exited	Temporal Period	D[b]	d[c]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance Components Days	%	Periods	%	Anglers	%
Late-run river harvest:													
Ferry	7/20-7/31	12	5										
Grayling	7/20-7/31	12	3	43	870	511	35,163	31,307	89	3,642	10	215	1
Pink Salmon	7/20-7/31	12	3	12	42	140	1,969	1,521	77	419	21	29	1
	Total 7/20-7/31					651	37,132						
Ferry	8/01-8/10	10	6	21	3,175	210	21,238	21,168	100	0	0	70	0
Grayling	8/01-8/10	10	4	108	1,145	1,075	37,161	17,182	46	19,459	52	520	1
Pink Salmon	8/01-8/10	10	3	73	1,291	732	42,402	30,132	71	11,999	28	271	1
	Total 8/01-8/10					2,017	100,801						
Ferry	8/11-8/20	6	2										
Grayling	8/11-8/20	10	4	94	3,934	942	69,503	59,017	85	10,211	15	275	0
Pink Salmon	8/11-8/20	10	2	50	2,813	495	116,500	112,500	97	3,750	3	0	0
	Total 8/11-8/20					1,437	185,753						
	Late-run river					4,105	323,686						
Late-run confluence harvest													
Ferry	7/20-7/31	12	5	459	72,114	5,511	1,505,594	1,211,513	80	290,935	19	3,147	0
Grayling	7/20-7/31	12	3	326	35,589	3,915	1,288,304	1,281,192	99	6,313	0	799	0
Pink Salmon	7/20-7/31	12	3	6	15	68	980	549	56	419	43	12	1
	Total 7/29-8/19					9,494	2,794,878						
Ferry	8/01-8/10	10	6	793	54,158	7,931	897,081	361,054	40	530,406	59	5,621	1
Grayling	8/01-8/10	10	4	247	11,212	2,466	309,566	168,184	54	140,459	45	923	0
Pink Salmon	8/01-8/10	10	3	19	76	185	4,316	1,768	41	2,540	59	7	0
	Total 8/01-8/10					10,582	1,210,963						
Ferry	8/11-8/20	6	2	196	1,518	1,175	82,016	18,210	22	63,259	77	547	1
Grayling	8/11-8/20	10	4	74	1,856	745	44,131	27,836	63	16,142	37	153	0
Pink Salmon	8/11-8/20	10	2										
	Total 8/11-8/20					1,920	126,147						
	Late-run confluence					21,996	4,131,988						
	Late-run total					26,101	4,455,674						

[a] Effort may not sum to Total because of rounding error.

[b] D = days possible in a stratum.

[c] d = days sampled in a stratum.

Appendix A4. Daily escapement of sockeye, coho, and chinook salmon through the Russian River weir during the late run, 1992.

Date	Early-Run Sockeye[a]	Late-Run Sockeye	Coho	Chinook
7/17	231	17		
7/18	34	1		
7/19	58	11		
7/20	68	21		
7/21	3	0		
7/22	9	3		
7/23	66	711		1
7/24	7	215		
7/25	10	487		
7/26	7	423		
7/27		961		
7/28		528		
7/29		742		
7/30		1,298		
7/31		2,130		2
8/01		2,072		
8/02		2,024		
8/03		3,969		2
8/04		2,974		
8/05		3,847		1
8/06		4,090		2
8/07		2,239	3	1
8/08		2,065		2
8/09		2,523	5	0
8/10		1,099	2	1
8/11		1,044	2	
8/12		1,064	2	
8/13		1,121	4	
8/14		3,265	10	
8/15		1,562	8	
8/16		1,866	6	
8/17		2,396	3	2
8/18		2,396	17	1
8/19		2,015	22	
8/20		927	1	
8/21		593	6	
8/22		1,541	15	
8/23		1,445	19	
8/24		782	7	

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Appendix A4. (Page 2 of 2).

Date	Early-Run Sockeye[a]	Late-Run Sockeye	Coho	Chinook
8/25		935	5	
8/26		773	23	
8/27		715	28	
8/28		924	40	
8/29		680	22	
8/30		453	25	
8/31		442	54	
9/01		277	36	
9/02		485	145	
9/03		258	74	
9/04		118	8	
9/05		134	17	
9/06		166	82	
9/07		128	68	
9/08		109	40	
9/09		54	20	
9/10		80	70	
9/11		94	62	
9/12		3	2	
9/13		53	22	
9/14		130[b]	336[c]	
Totals		63,478	1,315	15

[a] From 7/17 through 7/26, early-run fish were differentiated from late-run fish based on degree of external maturation, i.e., body coloration and kype development.

[b] An estimated 130 sockeye salmon remained downstream from the weir when it was dismantled on 9/14/92.

[c] An estimated 336 coho salmon remained downstream from the weir when it was dismantled on 9/14/92.